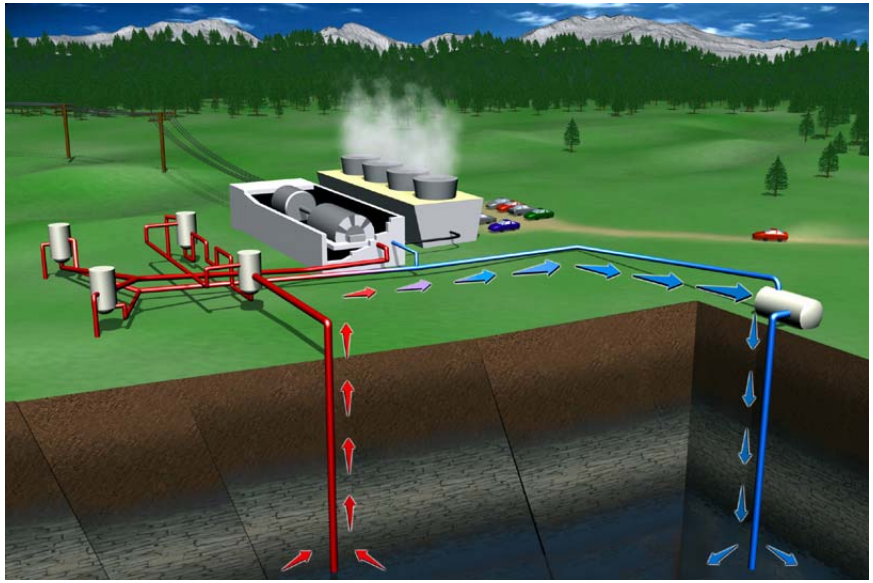
Geothermal Technologies Program

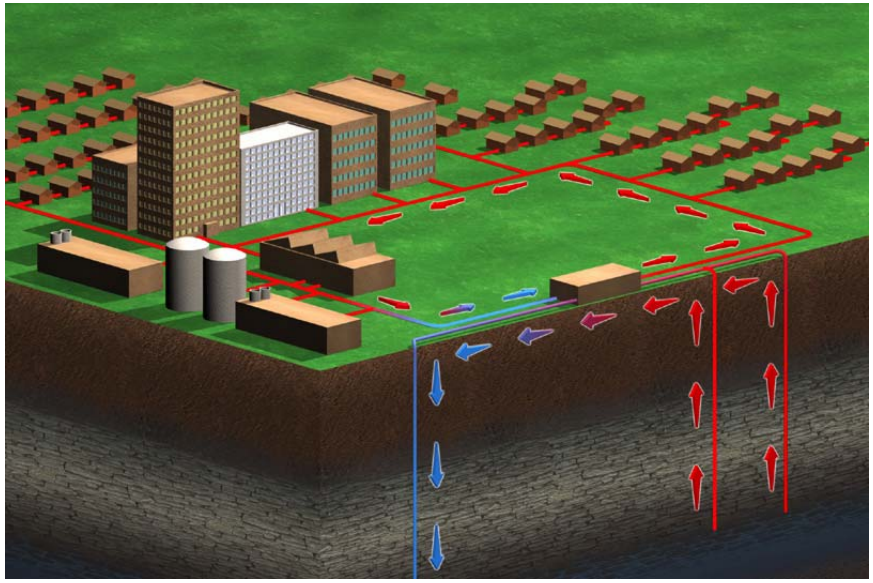
California Energy Commission
May 20, 2004

Roy Mink
Program Manager

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Geothermal Energy Technologies





Electricity Generation

- Distributed Power
- Central Station Power

Heat Production

- District Heating
- Process Heat
- Agriculture
- Aquaculture

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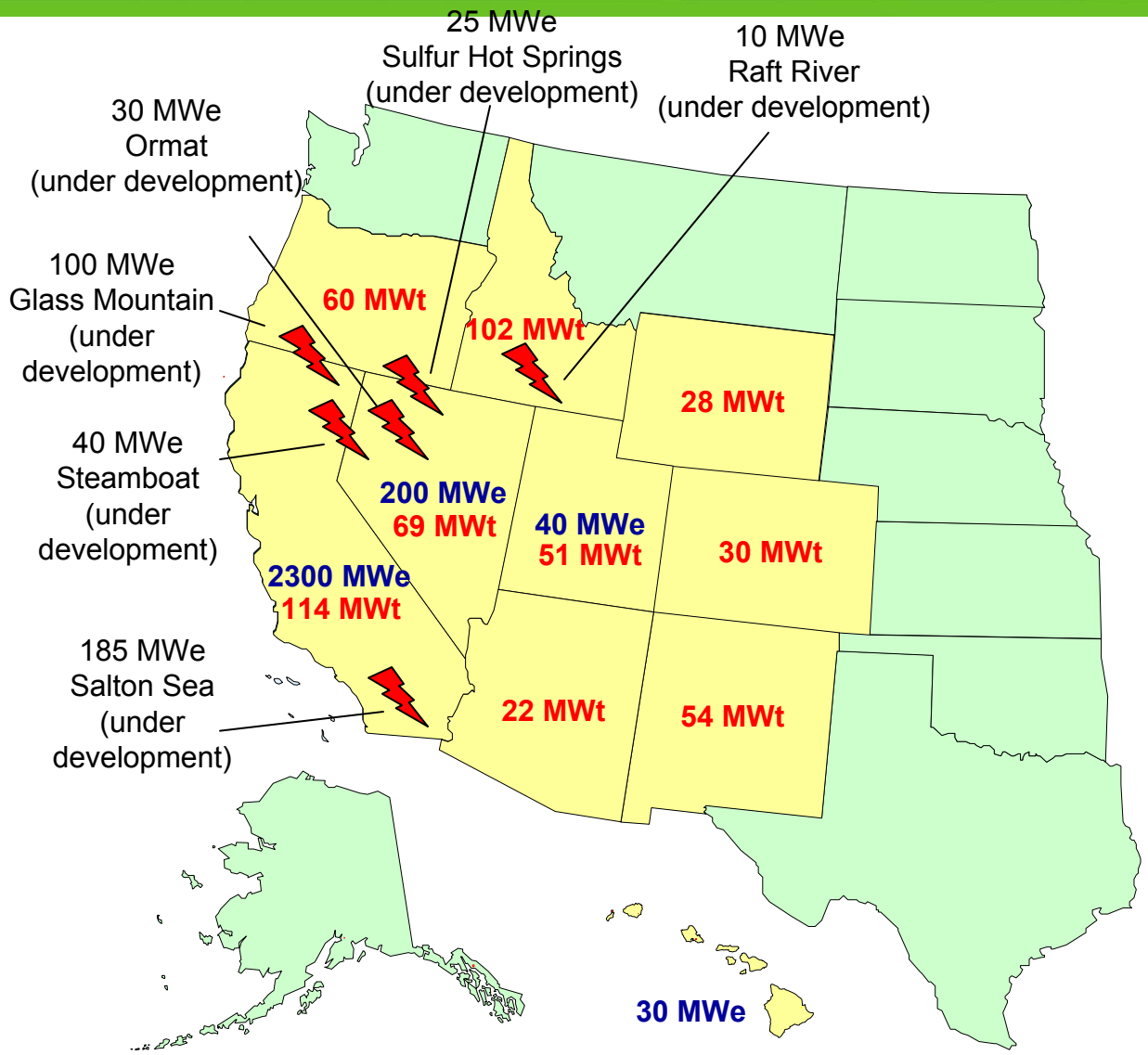
Present and Near-Term Capacity



Installed:

About 2600 MWe (electric)

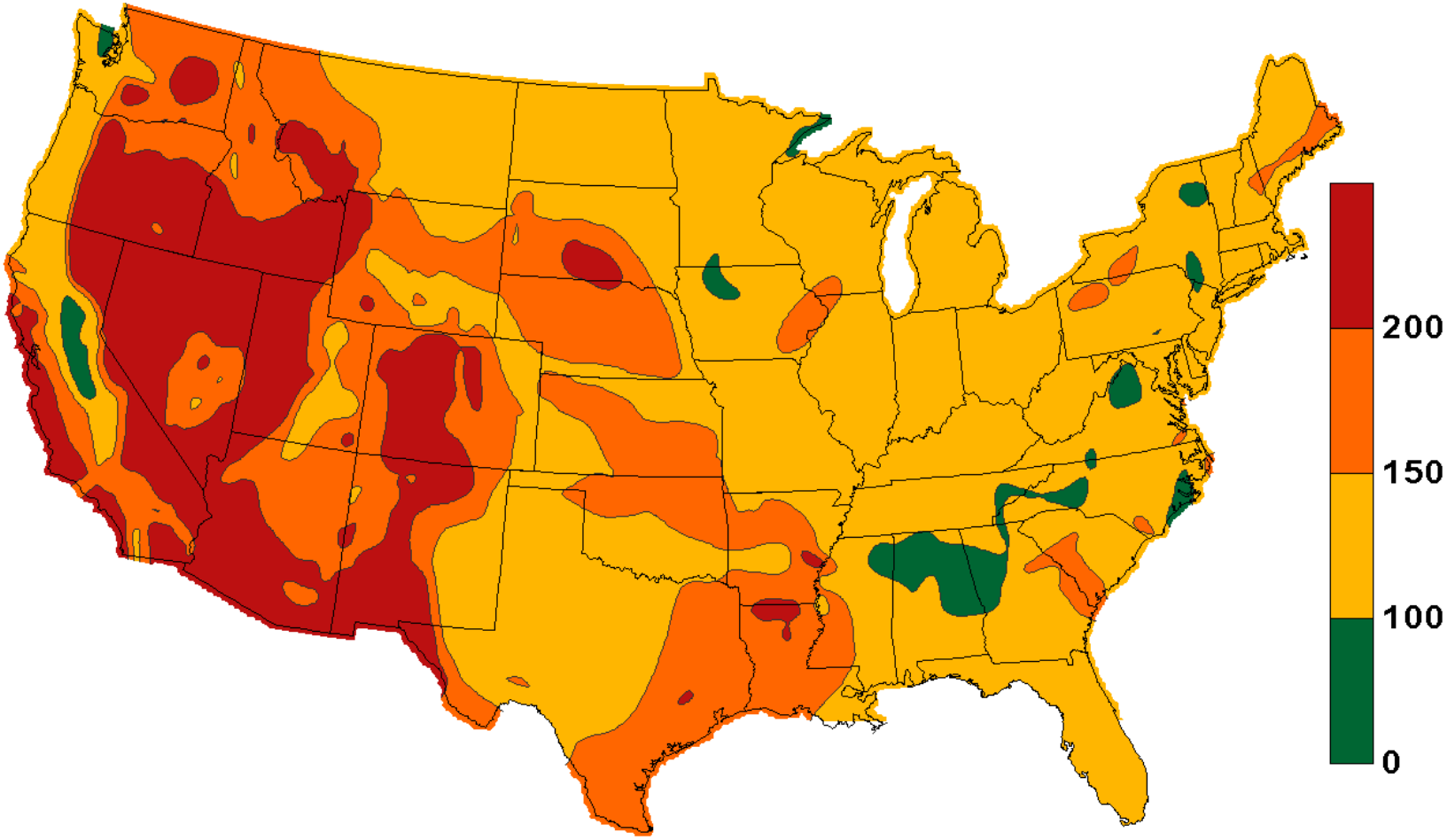
Over 600 MWt (heat)

400 MWe under development (electric)

More Than 20 MW

Less than 20 MW

Geothermal Resource Potential



Estimated Earth Temperatures at 6 km Depth (°C)

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Geothermal Energy Increasingly Competitive

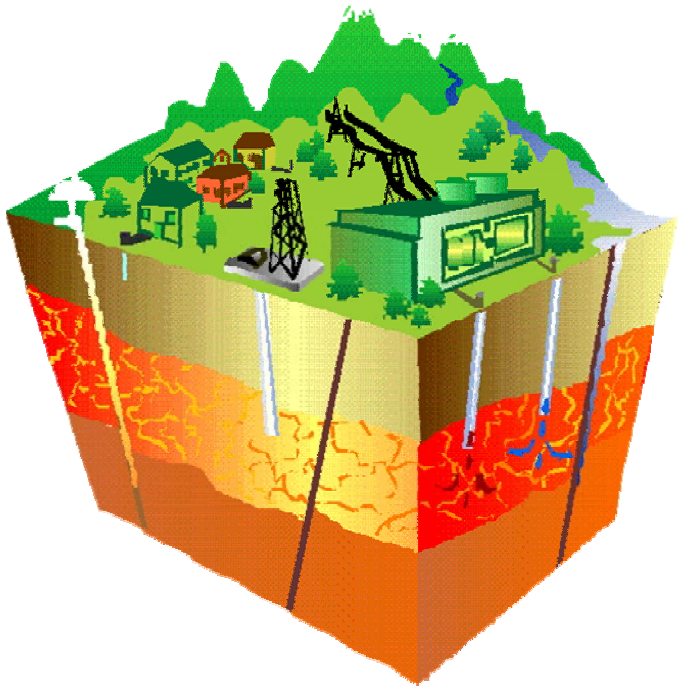
1980: 10-16 cents/kWh

2000:
5-8 cents/kWh

- Improved technology
- Reduced drilling costs
- Expanding resource base

2010 Goal: 3-5 cents/kWh

Program Vision and Mission



The Geothermal Technologies Program has a vision of geothermal energy as the nation's environmentally preferred baseload energy alternative.

The Program's mission is to work in partnership with U.S. industry to establish geothermal energy as an economically competitive contributor to the U.S. energy supply.

Program Goals

- Reduce the cost of hydrothermal power to 3-5 cents/kWh
- Reduce the cost of Enhanced Geothermal Systems power to 5 cents/kWh
- Increase the viable geothermal resource to 40,000 MW

Key Strategic Directions

- Enhanced Geothermal Systems
- Resource Assessment and Exploration Technology
- Advanced Drilling Technology
- Power Systems
- Education and Outreach

Enhanced Geothermal Systems (EGS)

Create hydrothermal reservoirs at sites lacking economic hydrothermal resources

- Conduct research on improved and innovative technologies for creating and managing EGS.
- Apply technological tools in partnership with industry at selected field locations.

Accomplishments to Date: Technical feasibility of EGS demonstrated at various sites

Present Status: Three cost-shared projects underway

Path Forward: Continue technology development and application with new cost-shared field projects in different geothermal environments. Increase emphasis on cost reduction.

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Exploration

Double the exploration success rate from 20 percent in 2000 to 40 percent, locating 20 new geothermal fields, by 2010

- Establish which exploration techniques are most effective, and work to improve these techniques.
- Update assessments and characterizations of known resources.
- Develop collaborative efforts with industry to support exploration for and definition of new geothermal resources.

Accomplishments to Date:

- Verified Steamboat Springs, NV resource for 42 MW plant
- Verified resources at Rye Patch, NV for planned 12 MW plant
- Proved that aeromagnetic surveys can help find hidden faults

Present Status:

- Reviewing applicability of modern remote sensing tools;
- Completing eight exploration projects, seven other projects continuing: New solicitation in FY04

Path Forward:

- Research to improve exploration tools
- Resource assessment in collaboration with state agencies and USGS to locate exploration targets
- Cost-shared exploration with industry

Resources:

- To be matched by resources from industry

Drilling

Reduce Cost of Drilling 25% by 2008 Compared to 2000 Costs

- Improve the component parts of a drilling system to perform essential functions quickly, reliably, and cheaply.
- Investigate long-term revolutionary advances in drilling materials and techniques with the target of drilling twice as deep for the same cost.

Accomplishments to Date:

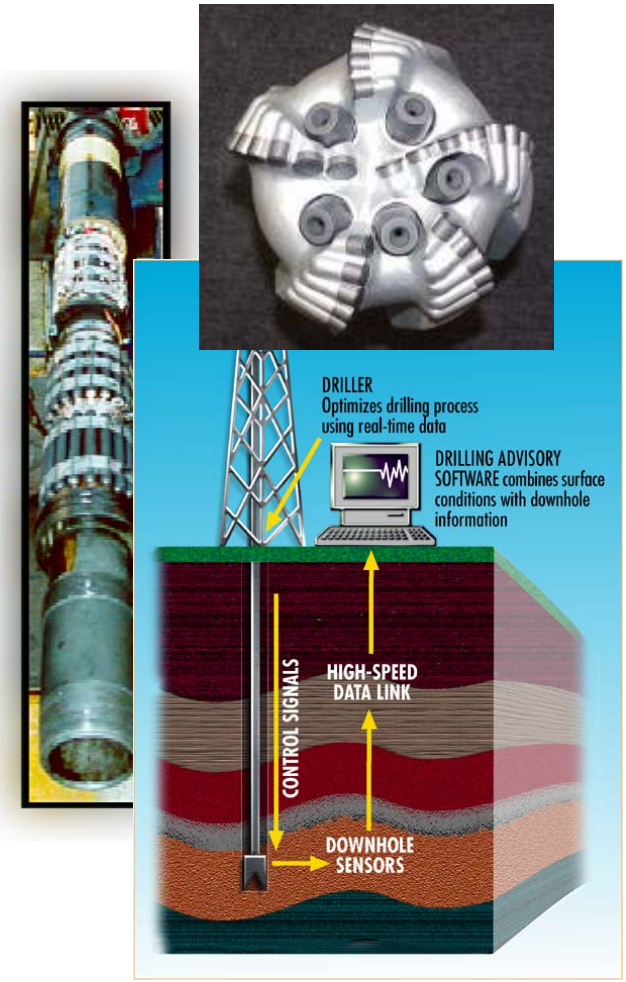
- Diagnostics While Drilling (DWD) proof of concept
- Hard rock drill bits
- Polyurethane grout for lost circulation control
- High-temperature integrated circuits for logging tool

Present Status:

- DWD system test with proprietary drill bits
- Drill bit database being developed
- Improvement of polyurethane deployment system

Path Forward:

- High-speed data link and smart sub-assembly for DWD
- Further improvements to polydiamond crystalline (PDC) drill bits
- Advanced drilling technologies



Power Systems

Reduce the capital cost of geothermal surface systems by 20 percent by 2010

- Develop heat rejection systems with major efficiency improvements, especially for lower-temperature resources.
- Develop advanced cycles using mixed working fluids that offer the potential for major efficiency improvements, especially for relatively low-temperature resources.
- Reduce operations and maintenance costs through optimized maintenance schedules, better construction materials, and hardier instruments.

Accomplishments to Date:

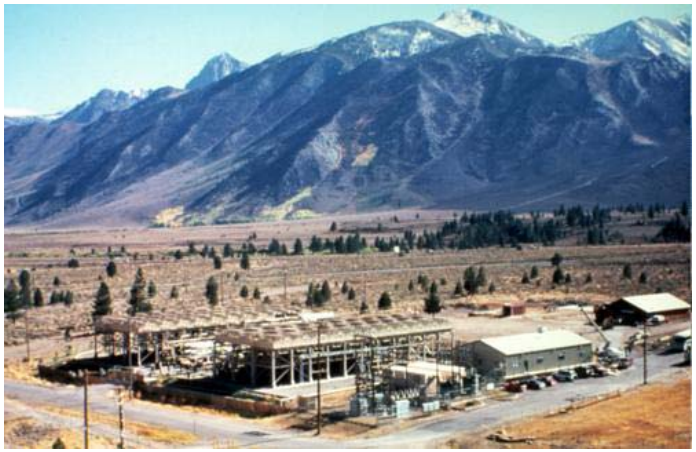
- Technology for Salton Sea metastable expansion
- Innovative condensers
- High performance coating materials

Present Status:

- Evaluating condensers to significantly increase air-side coefficient
- Validation of power plant technology
- Supporting technologies (monitors, non-condensing gases removal)

Path Forward:

- Innovative cycles
- Operating strategies
- Component improvements



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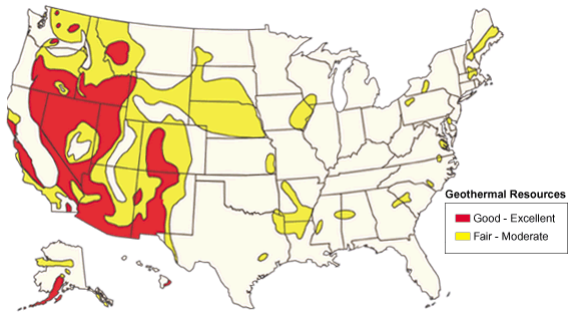
GeoPowering the West

GeoPowering the West



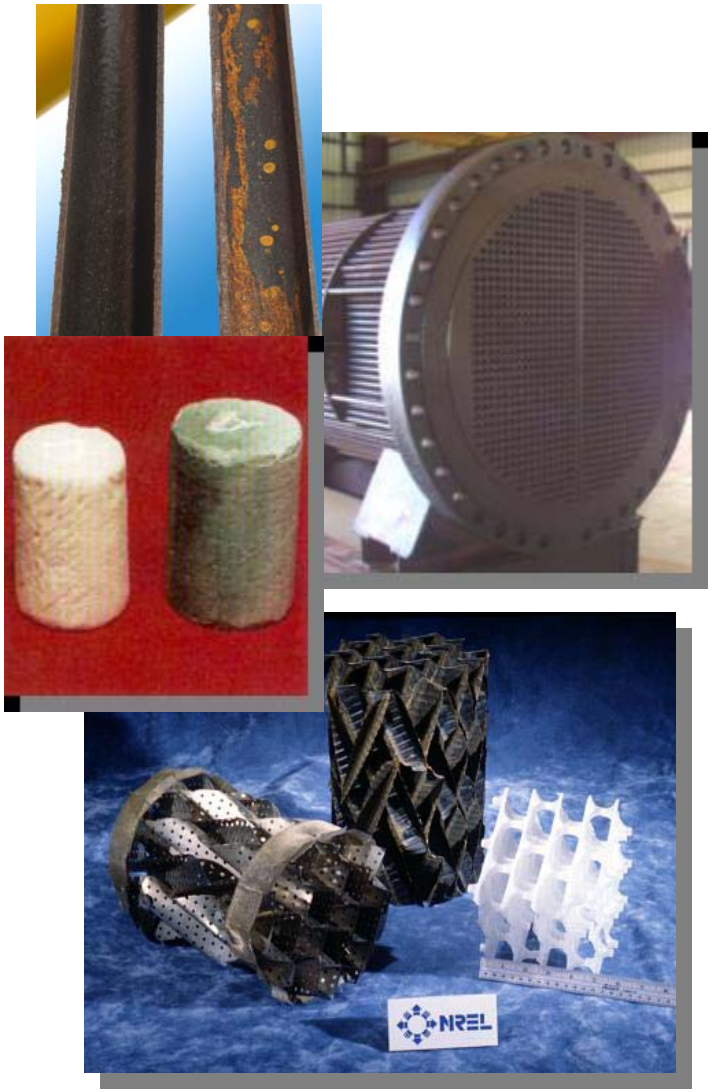
- DOE Leadership
  - State Geothermal Workshops/Working Groups
  - National Geothermal Collaborative
- State and Local Outreach
  - State Energy Program
  - Resource Mapping/Publications
  - Native American Involvement
  - Technical Assistance
- Industry Partnerships
  - Broad-Based Awards for Outreach Activities
  - Support for Direct-Use Community

Geothermal Budget

Funding Profile ($ thousands)

	FY2003	FY2004	FY2005 Request
Technology Development	**18,656**	**17,905**	**19,750**
- Resource Development	4,163	3,000	3,200
- Enhanced Geothermal Systems	5,915	6,680	8,000
- Systems Development	8,578	8,225	8,550
Technology Application	**9,734**	**7,603**	**6,050**
- Technology Verification	5,250	3,500	4,000
- Deployment	4,484	4,103	2,050
Total	**28,390**	**25,508**	**25,800**

Program Accomplishments



R&D 100 Awards

Acoustic Telemetry (FY2003)

- High Speed Data Link

Low Emission Atmospheric Monitoring Separator (FY2003)

CurraLon Coating System (FY2002)

- Low-cost alternative to high-alloy steels and titanium

Silica Recovery from Brine (FY2001)

- Produces high-quality silica as an added source of revenue

ThermaLoc CaP Cement (FY2000)

- Used in harsh, hostile environments
- Commercialized by Halliburton
- Significantly improves well economics

Advanced Direct Contact Condenser (FY1999)

- Increased output of Geysers Unit 11 by 5%

Factors Influencing Future Development

- Land Access and Permitting – Federal, State, and local
- Production Tax Credit for Geothermal
- Renewable Portfolio Standards
- Transmission
- Resource Assessment (USGS)